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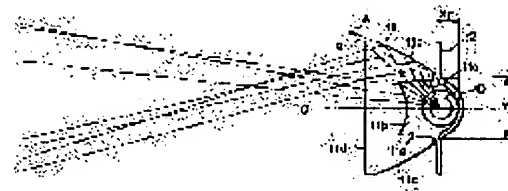
(21)Application number : 07-068194 (71)Applicant : FUJI PHOTO FILM CO LTD
(22)Date of filing : 27.03.1995 (72)Inventor : NAKA YOUJI

(54) ILLUMINATION DEVICE

(57)Abstract:

PURPOSE: To highly maintain condensing efficiency and to miniaturize an illumination device sufficiently in the illumination device shining divergent light emitted from a light source forward.

CONSTITUTION: A prism 11 provided with a first incident surface 11a on which the light emitted obliquely forward from the light source 10 is made incident, a total reflection surface 11c totally reflecting the light transmitted through the first incident surface 11a forward, a second incident surface 11b being a positive refracting surface on which the light emitted mainly forward from the light source 10 is made incident and an emitting surface 11d emitting the light transmitted through the second incident surface 11b and the light totally reflected on the total reflection surface 11c is arranged more forward than the center of the light source 10. Besides, this device is provided with a reflection mirror 12 reflecting the light emitted sideways and backward from the light source 10 mainly forward.



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CLAIMS

[Claim(s)]

[Claim 1] The lighting system which irradiates ahead the emission light which is characterized by providing the following, and which was emitted from the light source The 1st plane of incidence in which the light injected ahead [slanting] from the aforementioned light source carries out incidence The total reflection side which carries out total reflection of the light which has passed this 1st plane of incidence to a front side The 2nd plane of incidence which is a positive refracting interface in which the light mainly ahead injected from the aforementioned light source carries out incidence The reflecting mirror made to mainly reflect ahead the light injected to the side or back from the prism which has the injection side which makes the light which carried out total reflection in respect of the light which has passed this 2nd plane of incidence, and the aforementioned total reflection inject, and has been ahead arranged rather than the center of the aforementioned light source, and the aforementioned light source

[Claim 2] The 1st injection side which makes the light in which the injection side of the aforementioned prism mainly carried out total reflection in respect of [aforementioned] total reflection inject, The lighting system according to claim 1 characterized by making the injection side of prism into the shape of a cross-section concave as a whole when it is divided into the 2nd injection side which makes the light which has mainly passed the 2nd plane of incidence of the above inject and the aforementioned 1st injection side inclines to an irradiation optical axis.

[Claim 3] The lighting system according to claim 1 or 2 characterized by the 1st plane of incidence of the aforementioned prism being a flat surface which inclined 2-30 degrees to the irradiation optical axis.

[Claim 4] Depth x_r of the significant part of the aforementioned reflecting mirror And frontage y_r When the diameter of the light source is set to D , they are $D/2 \leq x_r \leq D$, respectively. Lighting system given [the claim 1 characterized by being in the range of $D < y_r \leq 2D$ to] in 3 any 1 terms.

[Claim 5] A lighting system given [the claim 1 characterized by being in the range of $D \leq y_{p1} \leq 2D$ when the frontage y_{p1} in the endpoint by the side of the light source of the 1st plane of incidence of the aforementioned prism sets the diameter of the light source to D to] in 4 any 1 terms.

[Claim 6] A lighting system given [the claim 1 to which the injection side of the aforementioned prism is characterized by being the appearance front face of a camera to] in 5 any 1 terms.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the lighting system which attained improvement and a miniaturization of condensing efficiency in detail especially about the lighting system used for a camera etc.

[0002]

[Description of the Prior Art] The stroboscope lighting system used for a camera etc. consists of optical members which lead fundamentally the emission light emitted from the light source and this light source to a front side, such as a reflecting mirror and prism.

[0003] Since more light emitted from the light source is condensed in a request field angle in such a lighting system, it is the former (1). As shown in JP,4-138438,A, the prism which has the total reflection side which turns and reflects in a front side the light injected to the side or back from the light source is used.

[0004] (2) As shown in JP,6-10712,B, extend a reflecting mirror for a long time, and make it deep at a front side (photographic subject side).

[0005] The composition of ** is proposed.

[0006]

[Problem(s) to be Solved by the Invention] However, in the composition of the above (1), since a part of optical plane of incidence (field which is made to carry out incidence of the light injected from the light source, and is made refracted towards the above-mentioned total reflection side) of prism was prolonged to the back of the light source, fully miniaturizing had the problem of being difficult.

[0007] Moreover, in the composition of the above (2), if it is going to gather condensing efficiency, a reflecting mirror will become long, and thereby, there is a problem that a lighting system will be enlarged.

[0008] this invention is made in view of the above-mentioned situation, and it aims at offering the lighting system high [condensing] and formed sufficiently small.

[0009]

[Means for Solving the Problem] In the lighting system which irradiates ahead the emission light emitted from the light source as the lighting system by this invention was mentioned above The 1st plane of incidence in which the light injected ahead [slanting] from the light source carries out incidence, and the total reflection side which carries out total reflection of the light which has passed this 1st plane of incidence to a front side, The 2nd plane of incidence which is a positive refracting interface in which the light mainly ahead injected from the light source carries out incidence, It has the injection side which makes the light which carried out total reflection in respect of the light which has passed this 2nd plane of incidence, and the above-mentioned total reflection inject. It is characterized by having the reflecting mirror made to mainly reflect ahead the light injected to the side or back from the prism ahead arranged rather than the center of the light source, and the light source.

[0010] In addition, in the above-mentioned composition, when it is divided into the 1st injection side which makes the light which mainly carried out total reflection in respect of [above-mentioned] total reflection inject, and the 2nd injection side which makes the light which has mainly passed the 2nd plane of incidence inject and the 1st injection side inclines to an irradiation optical axis, as for the injection side of prism, it is desirable to make the injection side of prism into the shape of a cross-section concave as a whole.

[0011] Moreover, as for the 1st plane of incidence of the above-mentioned prism, it is desirable that it is the flat surface which inclined 2-30 degrees to the irradiation optical axis.

[0012] Moreover, depth x_r of the significant part of the above-mentioned reflecting mirror And frontage y_r When the diameter of the light source is set to D , they are $D/2 \leq x_r \leq D$, respectively. It is desirable that it is in the range of $D < y_r \leq 2D$.

[0013] On the other hand, when the diameter of the light source is set to D , as for the frontage y_{p1} in the endpoint by the side of the light source of the 1st plane of incidence of the above-mentioned prism, it is desirable that it is in the range of $D \leq y_{p1} \leq 2D$.

[0014] Furthermore, as for the injection side of the above-mentioned prism, considering as the appearance front face of a camera is desirable.

[0015]

[Function and Effect(s) of the Invention] In the lighting system of this invention which has the above-mentioned composition, incidence is carried out to the 2nd plane of incidence of prism, it is condensed by this 2nd plane of incidence that is a positive refracting interface, and the light mainly ahead injected from the light source is injected to a front side. Moreover, after it carries out incidence of the light injected ahead [slanting] from the light source to the 1st plane of incidence of prism and it passes through that, total reflection of it is carried out in respect of total reflection, and it is injected to a front side. On the other hand, since incidence of the light injected from the light source to the side or back is carried out to a reflecting mirror and it mainly reflects ahead there, even if it arranges prism ahead rather than the center of the light source, condensing efficiency does not fall.

[0016] In the lighting system of this invention, the light injected from the light source to the side or back as above It is made to make it mainly reflect ahead with the reflecting mirror which can generally be formed thinly. prism Since it arranges ahead rather than the center of the light source so that only the light mainly injected the front and ahead [slanting] from the light source may carry out incidence, the front end of prism becomes low, and it miniaturizes, and the overall depth of equipment also becomes small, and the miniaturization of equipment is attained.

[0017] And rather than reflection [in / a reflecting mirror / in the total reflection in prism], since reflective efficiency is high, it can raise the use efficiency of light in which the lighting system of this invention came out of the light source compared with the lighting system using the conventional reflecting mirror.

[0018] Furthermore, since it comes to carry out incidence of it to a total reflection side after the light injected ahead [slanting] from the light source is refracted by the 1st plane of incidence of prism, this total reflection side is comparatively small, and ends, and prism is miniaturized also from this point, as a result the miniaturization of the whole equipment is attained.

[0019] Moreover, in the lighting system of this invention, adjustment of a luminous-intensity-distribution property will also become easy by changing the configuration of prism.

[0020]

[Example] Hereafter, the example of this invention is explained with reference to a drawing. Drawing 2 , and 3 and 4 show the side configuration, flat-surface configuration, and tropia configuration of the stroboscope lighting system by the 1st example of this invention, respectively, and drawing 1 shows the side configuration of the important section of this stroboscope lighting system. In addition, the equipment itself indicated to be (A) of drawing 1 to (B) is mutually the same, and (A) has shown tracing of the light which is emitted from the light source 10 in (B), and carries out incidence of the tracing of the light which it is emitted from the light source 10 and carries out incidence to prism 11 to a reflecting mirror 12.

[0021] This stroboscope lighting system consists of the light sources 10, such as Xe (xenon) pipe, prism 11 made from a transparent member ahead arranged rather than the center of this light source 10, and a reflecting mirror 12 which was missing from the side and was arranged from the back of the light source 10. In addition, 30 in drawing 2 -4 is a main part of a camera, and 35 is the case of a lighting system, and a silicon band for [36] light source maintenance in the trigger for luminescence control, and 37.

[0022] Prism 11 has 1st plane-of-incidence 11a, 2nd plane-of-incidence 11b which is a positive refracting interface, total reflection side 11c, and 11d of injection sides as shown in drawing 1 . Incidence is carried out to 2nd plane-of-incidence 11b of prism 11, it is condensed by this 2nd plane-of-incidence 11b that is a positive refracting interface, and the light mainly ahead injected from the light source 10 is injected to a front side as shown in this drawing (A). Moreover, incidence of the light injected ahead [slanting] from the light source 10 is carried out to 1st plane-of-incidence 11a of prism 11, and after it passes through that, total reflection of it is carried out by total reflection side 11c. The light which carried out total reflection by this total reflection side 11c is injected from 11d of injection sides to a front side, and mainly irradiates the photographic subject of an opposite side on both sides of an irradiation optical axis.

[0023] As a cross-section configuration of the above-mentioned total reflection side 11c, the combination of an ellipse, radii, and two or more radii, a flat surface, or the thing that combined two or more these is employable.

[0024] In addition, since incidence of it is carried out to total reflection side 11c after the light injected ahead [slanting] from the light source 10 is refracted in 1st plane-of-incidence 11a of prism 11 in the irradiation optical axis O and the direction in which the angle to make increases, this total reflection side 11c is comparatively small, and ends, and it can form prism 11 small. To (A) of drawing 1 , in order to turn to a front side the beam of light a injected ahead [slanting / from the light source 10] since the above refraction was not produced when using a reflecting mirror as shown in aforementioned JP,6-10712,B instead of such / incidentally / prism 11 and to make it reflect, as a dashed line shows, it is necessary to extend a reflecting mirror greatly to Point A.

[0025] On the other hand, incidence of the light injected from the light source 10 to the side or back is carried out to a reflecting mirror 12, and it is mainly ahead reflected there as shown in (B) of drawing 1 . In addition, this reflecting mirror 12 can be formed in an aluminum board and mould parts from what carried out aluminum deposition. Moreover, as the cross-section configuration, the combination of an ellipse, a hyperbola, radii, and two or more radii or the thing which combined two or more these is employable.

[0026] In this lighting system, the light injected from the light source 10 to the side or back as above While making it mainly reflect ahead with the thin reflecting mirror 12 and arranging prism 11 ahead rather than the center of the light source 10 Since the total reflection side 11c is formed small, the height yp2 of the front end of prism 11 becomes small, and it miniaturizes, and the overall depth xp2 of equipment also becomes small, and the miniaturization of equipment is attained.

[0027] In addition, since a moldability becomes good, the direction of surface reflection which inclined about 2-5 degrees to the irradiation optical axis O decreases and incidence efficiency of 1st plane-of-incidence 11a of prism 11 improves, it is desirable. However, if this inclination is too large, since it must extend with the endpoint near at hand by the side of the front of total reflection side 11c since the optical-refraction angle in 1st plane-of-incidence 11a becomes small and prism 11 will be enlarged, this tilt angle θ_{p2} is made into about 30 degrees at the maximum.

[0028] On the other hand, it is the depth xr of the significant part of a reflecting mirror 12. And frontage yr When the diameter of the light source is set to D, they are $D/2 \leq xr \leq D$, respectively. It is desirable that it is in the range of $D < yr \leq 2D$.

[0029] namely, $D/2 > xr$ it is -- ** -- prism 11 will have to be extended back and prism 11 will be enlarged Moreover, it is xr like the conventional reflecting mirror that it is $xr > D$. It follows on increase and is yr. You have to enlarge. Since it is desirable to maintain the relation of $yr \leq yp1$ about the frontage yp1 in the endpoint by the side of the light source of 1st plane-of-incidence 11a in order to make the light reflected with the reflecting mirror 12 go to 2nd plane-of-incidence 11b then, yp1 will also increase as a result and prism 11 will be enlarged. Moreover, since the light which goes to the slanting front in that case comes to face to a reflecting mirror 12, a predominance using prism 11 will be halved.

[0030] On the other hand, it is $D \geq yr$. In a case, it is the above-mentioned $D/2 \leq xr$. If a relation is satisfied, the cross-section configuration of a reflecting mirror 12 will turn into a configuration to which a frontage becomes small and which narrows the point, so that it approaches opening, and condensing efficiency will not become good. Moreover, a part manufacture top also becomes

disadvantageous. In the case of $y_r > 2D$, when the relation of above-mentioned $y_r \leq y_{p1}$ is maintained, y_{p1} will increase, and prism 11 will be enlarged in it.

[0031] Furthermore, when the diameter of the light source 10 is set to D , as for the frontage y_{p1} in the endpoint by the side of the light source 10 of 1st plane-of-incidence 11a of prism 11, it is desirable that it is in the range of $D \leq y_{p1} \leq 2D$. That is, it becomes difficult to lead efficiently the light reflected with the reflecting mirror 12 as it is $D > y_{p1}$ to 2nd plane-of-incidence 11b. On the other hand, prism 11 needs to place and arrange distance to some extent from the superficies of the light source 10, in order to lessen influence of the heat which the light source 10 generates. Endpoint P1 by the side of the light source of 1st plane-of-incidence 11a Although the distance with the light source 10 is decided by x_{p1} (refer to drawing 1) and y_{p1} , if it $y_{p1} = 2D$ is at least, the distance with the light source 10 is enough when avoiding the influence of heat. Therefore, a meaning is lost by about [that prism 11 is enlarged also as $y_{p1} > 2D$].

[0032] In addition, although the reflecting mirror 12 in this example consists of a cross-section semicircle-like portion and a straight-line-like portion which stands in a row to the ends, respectively mostly, the above-mentioned straight-line-like portion may be excluded.

[0033] In this 1st example equipment, since the portion which makes the light which mainly carried out total reflection by total reflection side 11c inject, and the portion of each other which makes the light which has mainly passed 2nd plane-of-incidence 11b inject are made into the same flat surface, as shown in drawing 2, 11d of this injection side can be used for 11d of injection sides of prism 11 as an appearance front face of a camera as it is.

[0034] moreover, the straight pipe-like thing which has a longitudinal direction as the light source 10 -- or a spherical thing is employable When adopting the former, prism 11 shall have a longitudinal direction and shall be mostly prolonged in parallel with the longitudinal direction of the light source 10. When you adopt the latter, let prism 11 be the thing of the symmetry of revolution about the irradiation optical axis O.

[0035] And the configuration of a reflecting mirror 12, the configuration of total reflection side 11c of prism 11, and the configuration of an inclination and 2nd plane-of-incidence 11b are adjusted so that a desired luminous-intensity-distribution property may be acquired.

[0036] Next, the 2nd example of this invention is explained. Drawing 5 shows the side configuration of the stroboscope lighting system by the 2nd example of this invention. In addition, the lighting system itself indicated to be (A) to (B) also by this drawing 5 is mutually the same, and (A) has shown tracing of the light which is emitted from the light source 10 in (B), and carries out incidence of the tracing of the light which it is emitted from the light source 10 and carries out incidence to prism 21 to a reflecting mirror 12. Moreover, in this drawing 5, a jack per line is given to an element equivalent to the element in drawing 1, and especially the explanation about them is omitted, as long as there is no need (following, the same).

[0037] The prism 21 with which the stroboscope lighting system of this 2nd example differs from the thing of the 1st example equipment is used. Although this prism 21 has 1st plane-of-incidence 21a, 2nd plane-of-incidence 21b which is a positive refracting interface, total reflection side 21c, and the injection sides 21d and 21e, the inclination θ_{p2} of total reflection side 21c is set up comparatively small, and it can be made to make small the vertical size y_{p2} of the front face of prism.

[0038] However, since the illuminating angle of the light which carried out total reflection by total reflection side 21c in this case tends to become large, the amendment injection side configuration is adopted in this. The 21d of namely, the 1st injection sides which make the light which mainly carried out total reflection of the injection side of prism 21 by total reflection side 21c inject, It is divided into 2nd injection side 21e which makes the light which has mainly passed 2nd plane-of-incidence 21b inject, and when the 21d of the above-mentioned 1st injection sides inclines to the irradiation optical axis O, the injection side of prism 21 is made into the shape of a cross-section concave as a whole. Therefore, in case the light which carried out total reflection by total reflection side 21c passes through the 21d of the 1st injection sides, it is refracted in the direction in which an illuminating angle becomes small.

[0039] In addition, in order to prevent it since dust etc. becomes easy to accumulate there if the portion with which the 21d of the above-mentioned 1st injection sides and 2nd injection side 21e are connected has become valley-like, you may connect the 21d of the 1st injection sides, and 2nd injection side 21e through a suitable curved-surface portion.

[0040] Next, the 3rd example of this invention is explained. Drawing 6 shows the side configuration of the stroboscope lighting system by the 3rd example of this invention. The prism 31 in this 3rd example equipment had 1st plane-of-incidence 31a, 2nd plane-of-incidence 31b which is a positive refracting interface, total reflection side 31c, and 31d of injection sides, and serves as the protector which protects the light source 10. And 31d of injection sides of this prism 31 is leaned to the irradiation optical axis O so that it may have consistency with the front face to which the main part 30 of a camera inclined.

[0041] Next, the 4th example of this invention is explained. Drawing 7 shows the side configuration of the stroboscope lighting system by the 4th example of this invention. The prism 41 in this 4th example equipment also had 1st plane-of-incidence 41a, 2nd plane-of-incidence 41b which is a positive refracting interface, total reflection side 41c, and 41d of injection sides, and serves as the protector which protects the light source 10. [as well as the prism 31 of the 3rd example equipment] And 41d of injection sides of this prism 41 is leaned to the irradiation optical axis O so that it may have consistency with the front face to which the main part 30 of a camera inclined.

[0042] With the 3rd example equipment explained previously, there is an inclination for irradiation light to incline toward the bottom, by having leaned 31d of injection sides of prism 31 to the irradiation optical axis O. Then, in this 4th example, while upper total reflection side 41c makes an inclination size comparatively, and lower total reflection side 41c makes an inclination smallness comparatively, 2nd plane-of-incidence 41b is also leaned to the irradiation optical axis O. By doing in this way, comparison of beam-of-light tracing of drawing 6 and drawing 7 amends the bias of irradiation light mentioned above so that clearly.

[0043] Next, the 5th example of this invention is explained with reference to drawing 8, and 9 and 10. Drawing 8 and 9 show the flat-surface configuration of the stroboscope lighting system by the 5th example of this invention, and a side configuration, respectively, and the tropia configuration of prism 51 where drawing 10 is used for it and shown. In addition, the reflecting mirror 12 is excluded in drawing 8.

[0044] The prism 51 in this 5th example equipment also has 1st plane-of-incidence 51a, 2nd plane-of-incidence 51b which is a positive refracting interface, total reflection side 51c, and 51d of injection sides. And 51d of injection sides of this prism 51 is made into the vertical Fresnel lens configuration.

[0045] By having made 51d of injection sides of prism 51 into the above configurations, the light from the straight pipe-like light source 10 is condensed to the longitudinal direction, and a desired luminous-intensity-distribution property can be acquired. In addition, contrary to this, it is possible to also make the longitudinal direction of the straight pipe-like light source 10 emit light according to the configuration of a Fresnel lens.

[0046] Next, the 6th example of this invention is explained with reference to drawing 11. Drawing 11 shows the flat-surface configuration of the stroboscope lighting system by the 6th example of this invention. In addition, illustration is omitted although the same reflecting mirror 12 as what was used for each above-mentioned example is formed also in this example. 61d of injection sides of the prism 61 in this 6th example equipment is made into the cylindrical-lens configuration. Thereby, the light from the straight pipe-like light source 10 is condensed to the longitudinal direction, and a desired luminous-intensity-distribution property can be acquired. In addition, contrary to this, it is possible to also make the longitudinal direction of the straight pipe-like light source 10 emit light according to the configuration of a cylindrical lens.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The side elevation of the important section of the lighting system by the 1st example of this invention

[Drawing 2] The above-mentioned 1st example equipment is a fracture side elevation a part.

[Drawing 3] The above-mentioned 1st example equipment is a fracture plan a part.

[Drawing 4] The perspective diagram of the above-mentioned 1st example equipment

[Drawing 5] The side elevation of the lighting system by the 2nd example of this invention

[Drawing 6] The side elevation of the lighting system by the 3rd example of this invention

[Drawing 7] The side elevation of the lighting system by the 4th example of this invention

[Drawing 8] The plan of the lighting system by the 5th example of this invention

[Drawing 9] The side elevation of the above-mentioned 5th example equipment

[Drawing 10] The perspective diagram showing some above-mentioned 5th example equipments

[Drawing 11] The plan of the lighting system by the 6th example of this invention

[Description of Notations]

10 Light Source

11, 21, 31, 41, 51, 61 Prism

11a, 21a, 31a, 41a, 51a The 1st plane of incidence of prism

11b, 21b, 31b, 41b, 51b The 2nd plane of incidence of prism

11c, 21c, 31c, 41c, 51c, 61c Total reflection side of prism

11d, 31d, 41d, 51d, 61d Injection side of prism

12 Reflecting Mirror

21d The 1st injection side of prism

21e The 2nd injection side of prism

30 Main Part of Camera

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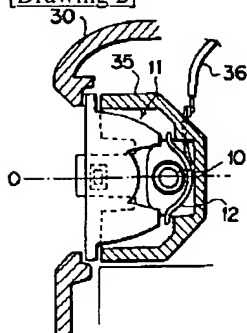
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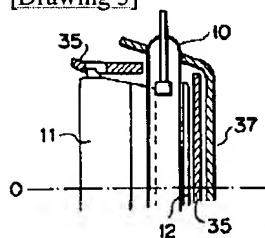
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DRAWINGS

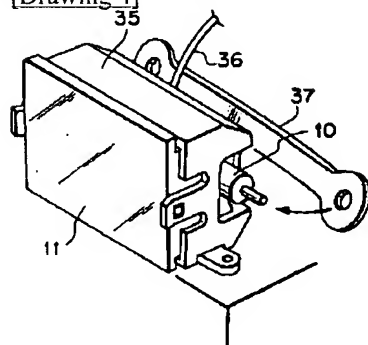
[Drawing 2]



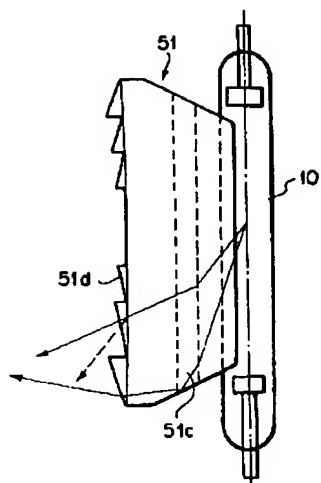
[Drawing 3]



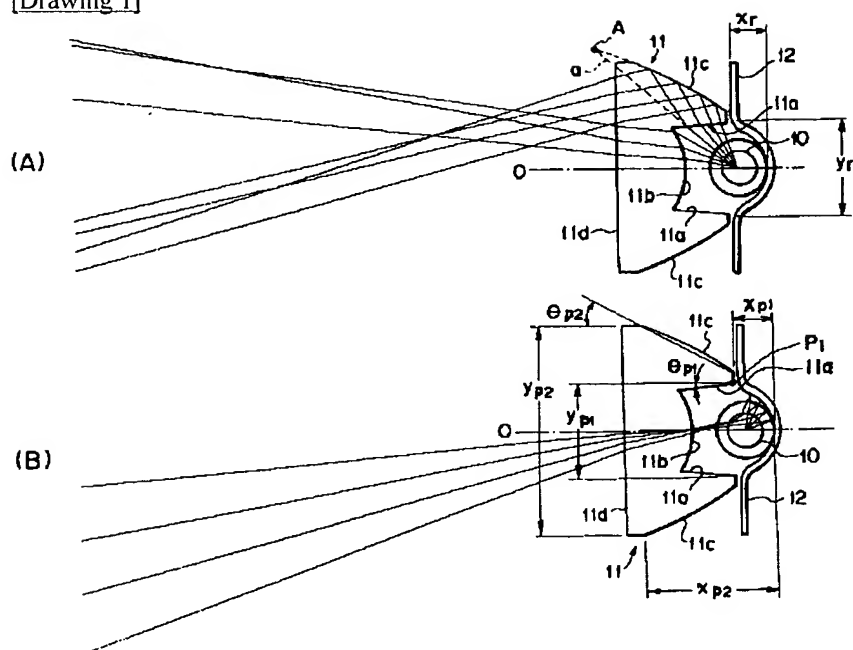
[Drawing 4]



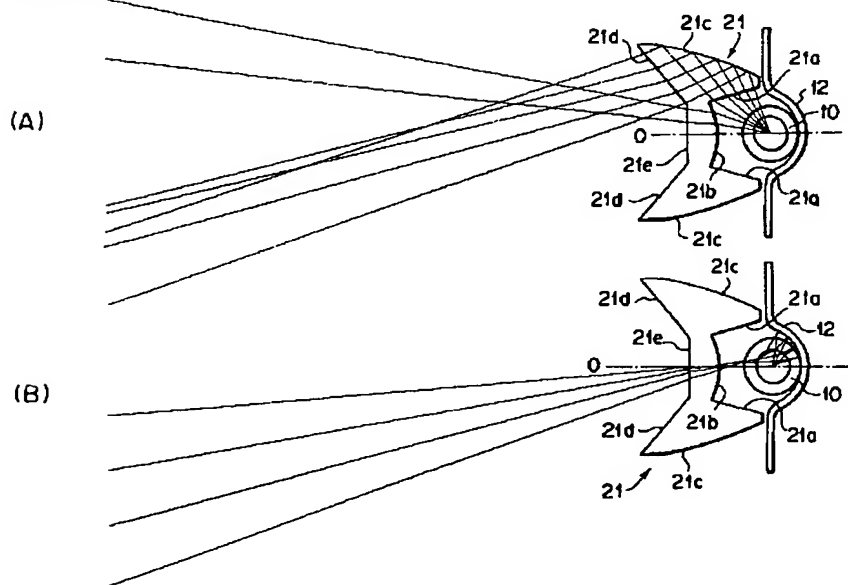
[Drawing 8]



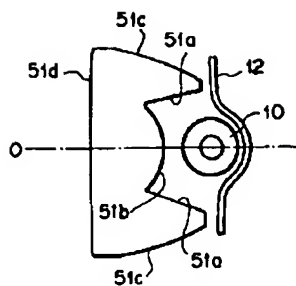
[Drawing 1]



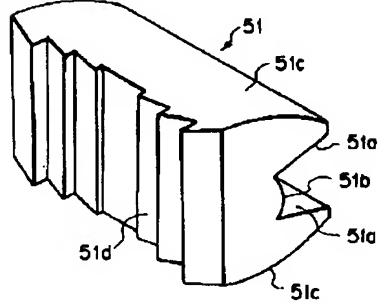
[Drawing 5]



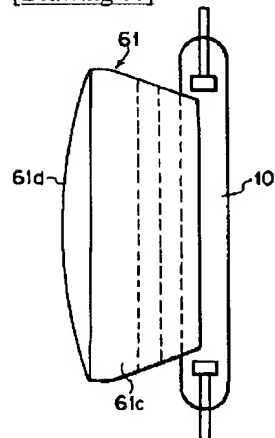
[Drawing 9]



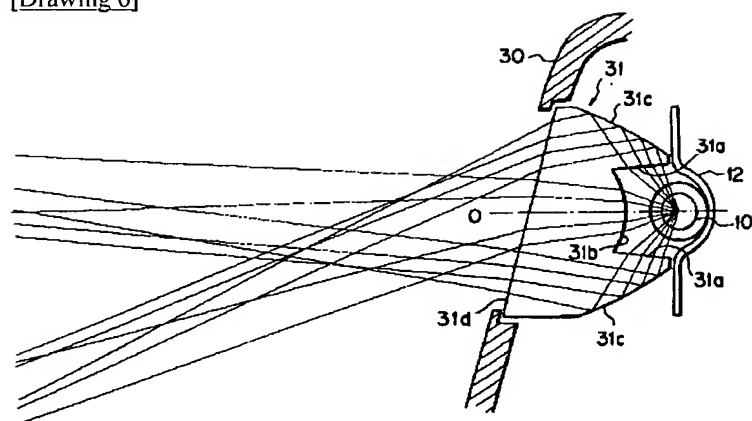
[Drawing 10]



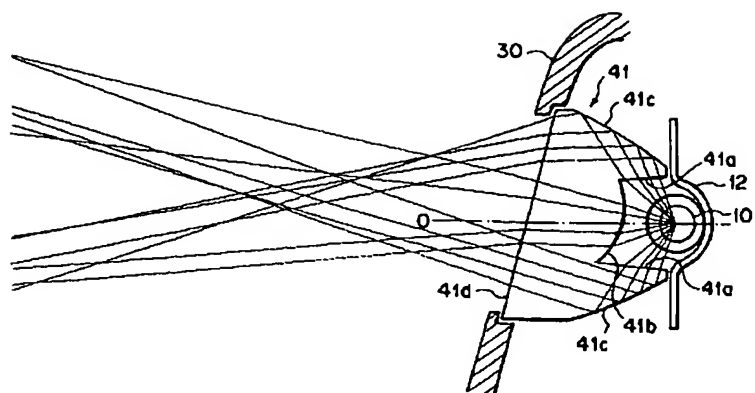
[Drawing 11]



[Drawing 6]



[Drawing 7]



[Translation done.]